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briefly the circumstances under which the study was begun, developed, and brought to completion. A brief but interesting chapter is devoted to a history of botanical exploration in Porto Rico from the earliest collections made in 1785–1786 to the recent expeditions by different members of the staff of the New York Botanical Garden. A careful tabulation shows that 2056 species, representing 167 families of Pteridophytes and Phanerogams, are known from the island at the present time. Of this number 271 species, or 13.13 per cent, are peculiar to the island. The families best represented in numbers of species are: Polypodiaceae (182), Leguminosae (136), Gramineae (122), Compositae (90), Orchidaceae (86), and Cyperaceae (85). From a detailed analysis of the species recorded, Professor URBAN concludes that the flora of Porto Rico is most closely allied to that of South America. A very complete index to the Latin and vernacular names terminates the volume. The work forms a reliable and authoritative basis for future investigations on the flora of this interesting and economically important insular territory.—J. M. GREENMAN.

Flora of Formosa.—Since the publication of the *Enumeratio plantarum Formosanarum* in 1906 and the *Flora montana Formosae* in 1908, investigations on the flora of the island of Formosa have been pushed forward with astonishing vigor, which is amply attested to by the appearance of another volume entitled *Materials for a flora of Formosa.*[7] The author in the present volume has attempted to enumerate all species recorded from the island since the publication of the works mentioned above. Flowering plants, ferns, and fern-allies only are included, and these are chiefly from the mountainous regions of the island. Over 700 species are listed, representing 343 genera and 109 families, thus making the total number of species known up to the present time 2660, representing 836 genera and 156 families. The work of identification of the plants on which this contribution to knowledge is based has been carried on at Tokyo, Kew, Paris, Berlin, and St. Petersburg, and over 300 species and several varieties are characterized as new to science. The location of the island of Formosa is such that its flora is composed of elements common to Japan, China, India, and the Malayan region. The large number of novelties recorded is suggestive of a very rich and varied flora, and indicates, moreover, that Formosa is still a fruitful field for further taxonomic investigation.—J. M. GREENMAN.

NOTES FOR STUDENTS

Biology of rusts.—MÜHLETHALER, who has made a large number of cultural experiments with the crown rusts of grasses in Switzerland, has given a complete account of his investigations, a part of the results of which have already been published in a preliminary account.[8] Since DEBARY's demonstration of the connection between the crown rusts of grasses and the aecidia occurring on species of *Rhamnus*, these rusts have been more especially investigated by ERIKSSON and by KLEBAHN, with the result that two species have been differentiated: *Puccinia coronata* (Corda) Kleb. with aecidia chiefly on *Rhamnus Frangula;* and *P. coronifera* Kleb. with aecidia chiefly on *R. cathartica.* These comprise several form-species whose teleutospore generation in each case is confined to a small group of grasses. To these collective species MÜHLETHALER[9] has added a third, described as *P. alpinae-coronata* with aecidia on *Rhamnus alpina* and *R. pumila.*

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[7] HAYATA, B., Materials for a flora of Formosa. Jour. Sci. Coll. Tokyo **30**:1–471. 1911.

[8] Rev. BOT. GAZ. **51**:157. 1911.

The cultural work, which covers an unusually large number of infection experiments, emphasizes more strongly the facts already suggested in the work of KLEBAHN and of ERIKSSON, that the crown rusts are not so strictly limited, in their specialization, to certain hosts as some of the earlier experiments would seem to indicate, and that some of the form-species formerly established should not be kept separate. Thus, for example, the form occurring on the members of the genus *Lolium* can be transferred to members of the genus *Festuca*, showing that a sharp separation of f.sp. *Lolii* and f.sp. *Festucae* is impossible. There is also evidence to show that the degree of specialization of different forms is not the same in different regions, a fact which JACZEWSKI[10] has already pointed out in his studies on Russian grain rusts. Unfortunately, the present experiments were not continued long enough to bring out all the interrelationships of the different form-species. The cultures reported comprised (1) infection of grasses either directly by aecidiospores, or indirectly by uredospores derived from the aecidiospore infection; and (2) infection of members of the genus *Rhamnus* by teleutospores from these grasses. The aecidial material was mostly gathered in its native habitat, so that there could be no assurance of its purity, and the experiments were not continued long enough to isolate with certainty the different form-species whose aecidia occur on the same species of *Rhamnus.* For these reasons, no attempt is made in this review to distinguish between the different form-species. For experimental evidence bearing on this point the original paper must be consulted.

Aecidiospores from *Rhamnus Frangula*, or the uredospores derived from these, infected *Phalaris arundinacea*, *Calamagrostis arundinacea*, *Glyceria fluitans*, and *Anthoxanthum ordoratum* (doubtful). Teleutospores (sporidia) from *Phalaris arundinacea* infected *Rhamnus Frangula*, *R. Purshiana*, *R. californica*, *E. imeretina* (spermagonia), and *R. alaternus* (spermagonia).

Aecidiospores from *Rhamnus cathartica*, or the resulting uredospores, infected, in one series, *Lolium perenne*, *L. rigidum*, *L. italcum*, *L. temulentum*, *L. remotum* var. *aristatum*, *Festuca elatior*, *F. arundinacea*, *Phleum pratense* (poorly), and *Dactylis glomerata* (poorly). The teleutospores from *Lolium*

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[9] MÜHLETHALER, F., Infektionsversuche mit *Rhamnus* befallenden Kronenrosten. Centralbl. Bakt. II. **30**:386–419. 1911.

[10] Rev. BOT. GAZ. **51**:75. 1911.

perenne and *L. rigidum* infected *Rhamnus cathartica*, *R. utilis*, *R. dahurica*, *R. saxatilis*, and *R. imeretina*. In another series the aecidiospores from *R. cathartica*, or the resulting uredospores, infected *Bromus erectus* and its var. *condensatus*, *B. sterilis*, *B. inermis*, *B. tectorum*, *B. secalinus*, *B. commutatus*, *Festuca varia*, *F. arundinacea*, *F. alpina*, *F. gigantea*, *F. violacea*, *F. rubra* (poorly), and *Lolium perenne* (1 sorus). The teleutospores from *Bromus erectus* (collected in nature) infected *Rhamnus cathartica*, *R. utilis*, *R. saxatilis*, and *R. dahurica;* and the teleutospores from the foregoing aecidial infection on *Festuca arundinacea* infected *R. cathartica*, *R. utilis*, *R. dahurica*, *R. saxatilis*, *R. imeretina*, and *R. alaternus*.

Aecidiospores from *Rhamnus pumila* infected *Calamagrostis varia*, and the teleutospores from this grass infected *R. pumila*, *R. alpina*, *R. Purshiana*, *R. californica*, *R. imeretina*, and *R. Billardi* (spermagonia).

The following cultural experiments with rusts are reported by MAYOR[11] in Neufchatel, Switzerland. The form of *Puccinia* on *Carex digitata* infected *Ribes alpinum* and *R. Grossularia*, and that on *C. glauca* infected *R. alpinum*, the reverse sowing being also made in the latter case. The forms of *Puccinia* on these two species of *Carex*, therefore, belong to the Ribesii-Caricis group of KLEBAHN, but the data are insufficient for determining if they belong to any of the five species into which KLEBAHN has divided that group. To the hosts of *Puccinia longissima* whose alternate generations occur on species of *Koeleria* and *Sedum* the author adds *K. valesiaca*, teleutospores from that host having infected *Sedum reflexum*. A form of *Puccinia* from *Carex muricata* infected *Crepis biennis* but not *Taraxacum*. It seems, therefore, that this rust is distinct from *P. sylvatica*. *Puccinia Actaeae-Elymi* is described as a new form with teleutospores on *Elymus europaeus* and aecidia on *Actaea spicata*. This form does not infect *Triticum caninum* and therefore is distinct from *P. Actaeae-Agropyri* Fischer, which has teleutospores on that host and aecidia on *Actaea spicata*.

A series of infection experiments made by DIETEL[12] with *Hyalospora Polypodii* on *Cystopteris fragilis* is the first attempt at cultural experiments with a fern rust. *Hyalospora* produces thin-walled and thick-walled uredospores, and apparently only rarely teleutospores. Sowings were made on *Cystopteris* both with fresh uredospores and with uredospores that had been left in the open during the winter. In both cases infection occurred easily. In the newly formed sori thin-walled uredospores were first produced, and these were followed later by the thick-walled form. Teleutospores were not observed. The author believes, as a result of these experiments and the rare occurrence of the teleutospores, that this rust normally maintains itself by means of the hibernating uredospores.

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[11] MAYOR, EUG., Récherches expérimentales sur quelques Urédinées hétéroiques. Ann. Mycol. **9**:341–362. *figs. 3.* 1911.

[12] DIETEL, P., Über einige Kulturversuche mit *Hyalospora Polypodii* (Pers.). Magn. Ann. Mycol. **9**:530–533. 1911.

In a paper which is the eleventh of a series of reports on his well-known cultural work with plant rusts, carried on since 1899, ARTHUR gives the results of the cultures of 1910.[13] The work of that year was under the immediate charge of Miss IRMA A. UHDE. Sowings of spores of 21 species of rusts on a large number of possible aecidial hosts gave no infections. Successful cultures with 34 species supplemented or confirmed the results previously obtained either by the author or by other American and European investigators. The following six forms have been connected with their antithetic generation for the first time: *Puccinia Crandalii* Pam. & Hume on *Festuca confinis* Vasey and *Symphoricarpus racemosus* Michx.; *P. quadriporula* Arth. on *Carex Goodenovii* J. Gay and *Aster paniculatus* Lam.; *Puccinia Lithospermi* E. & K. on *Evolvulus pilosus* Nutt., autoecious; *Uromyces acuminatus* Arth. on *Spartina Michauxiana* A. S. Hitch. and *Polemonium reptans* L.; *Coleosporium Vernoniae* B. & C. on *Vernonia crinita* Raf. and *Pinus Taeda* L. (aecidiospores sown on *Vernonia*); and *Melampsora Albertensis* Arth. on *Populus tremuloides* Michx. and *Pseudotsuga mucronata* (Raf.) Sudw.

The host relations of some of the *Peridermium* rusts in Nova Scotia have been studied by FRASER,[14] who, in addition to a number of field observations, reports cultures with the following forms. Teleutospores of *Melampsoropsis Cassandrae* (Peck and Clinton) Arth. from *Chamaedaphne calyculata* (L.) Moench sown on *Picea rubra* (Du Roi) Dietr. produced *Peridermium consimile* Arth. & Kern. Teleutospores of *M. abietina* (Alb. & Schw.) Arth. from *Sedum groenlandicum* Oeder also sown on *Picea rubra* produced *Peridermium abietinum* (Alb. & Schw.) Thüm. *M. ledicola* (Peck) Arth. from *Ledum* produced *Peridermium decolorans* Peck on *Picea canadensis.* One form, *Uromyces Peckiananus* Farlow on *Distichlis spicata* (L.) Greene, not belonging to the *Peridermium* rusts, produced aecidia on *Atriplex patula* var. *hastata* (L.) Gray and *Chenopodium album* L.

FISCHER'S[15] review of the work done on the biology of rusts in 1910 will be of interest to students of this group.—H. HASSELBRING.

Cytology of the Basidiomycetes.—Among the many papers which have lately appeared on the cytology of the higher fungi, three are of more than usual interest. FRIES,[16] in a brief paper on *Nidularia*, finds the mycelium and young basidia binucleated, the nuclei having the chromatin in two conspicuous masses. The nuclei increase in size with the growth of the basidium, gradually

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[13] ARTHUR, J. C., Cultures of Uredineae in 1910. Mycologia **4**:7–33. 1912.

[14] FRASER, W. P., Cultures of some heteroecious rusts. Mycologia **3**:67–74. 1911.

[15] FISCHER, ED., Die Publicationen über die Biologie der Uredineen in Jahre 1910. Zeitschr. Bot. **3**:620–623. 1911.

[16] FRIES, ROB. E., Über die cytologischen Verhältnisse bei der Sporenbildung von *Nidularia*. Zeitschr. Bot. **3**:145. 1911.